$D_x y$ — after the first — were found to be almost the same. To obtain an absolutely reliable equation, it is necessary to take a great many points very near together; and as each point raises the equation one degree, and adds one more equation to those from which the coefficients are found, the mere mechanical work of finding the equation of the curve becomes very great.

No. XXV. — EFFECT OF THE TENSION OF MEMBRANES ON SOUND.

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Several experiments were tried bearing upon this subject by speaking alternately through two telephones, the mouth of one being covered with a membrane and the mouth of the other being open, the difference in sound between the two being observed by means of a telephone in the circuit. These experiments were not thought trustworthy, as it was difficult to speak with equal intensity and at precisely the same distances from the two instruments; to obviate these difficulties the following apparatus was devised.

An ordinary Bell telephone was provided with two tubes, which were placed opposite to each other on opposite sides of the vibrating plate. Rubber tubes were slipped upon these two tubes and led away to a mouth-piece which consisted of a chamber of clay, so moulded as to allow the extremities of the rubber tubes to terminate in broad glass funnels which were imbedded at a certain angle with each other in the clay. Another telephone was included in the circuit to enable one to hear what was transmitted.

Sounds sent to the telephones by both the mouth-pieces in the clay chamber would not be heard at the receiving telephone, because the equal vibrations striking opposite sides of the sending telephone plate would neutralize each other, but by closing alternately the connecting tubes the sound can be passed at will through either of the mouth-pieces.

In experimenting with the voice it was found that, with both a loose and a tight membrane, the articulation was plainer, and the sounds somewhat louder, than when passed through the open mouth-piece.

It was also noticed that the vowels were broadened, *ă* becoming *ā*, etc., the effect of the tight membrane in both cases being the strongest.

Musical sounds passed through a tight membrane appeared much louder, and those of the highest pitch much more intense, than when passed through the open mouth-piece. While experimenting with sounds of a low pitch passed through a tight membrane, it was noticed that, while the fundamental tone was hardly perceptible, the first harmonics could be plainly heard. This fact seems to have the following explanation: the membrane being found to be much more sensitive to sounds of a higher pitch than to those of a lower, when the low tone was sounded the membrane transmitted the vibrations of the harmonics sounding with it, of a higher pitch than the fundamental tone, before the fundamental tone itself. Without the membrane no such effect was produced. Loose membranes gave the same effect, though relatively to the experiments with the voice much less intense, being weaker than the sound transmitted through the open mouth-piece.

While trying the above experiments the idea suggested itself that two telephones placed end to end, having one diaphragm in common and furnished with two mouth-pieces connected by long tubes, would furnish an instrument for measuring reflected sound. Such an instrument could be used as follows. Place one of the mouth-pieces to receive the direct and the other the reflected sound. Now, if the two sounds were equal, nothing would be heard at the telephone placed in the circuit for the observer, as proved by the result of the experiment made in transmitting one sound through two mouth-pieces. If one sound was stronger than the other, its vibrations would be transmitted, and it would be heard.

If a thumb-screw with a scale be fitted on the tube through which the stronger sound passes, by compressing the tube by means of the screw the intensity of the sound can be graduated till nothing is heard by the observer, thus proving the two to be equal.

Reading the number of turns from the scale, the relative intensities of the two sounds can be measured, and if the scale be made so that a certain number of turns equals a sound of a certain intensity, the measurement becomes positive instead of relative.